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(54) Field sprayer monitor

(57) A sprayer monitor system for indicating to an operator various parameters such as the rate of application of fluid, the volume applied, the true ground speed and the area covered. Speed 10 and fluid flow 11 pulse signals related to vehicle speed and fluid flow rate are applied to a control circuit 6 which has constants stored during calibration. With an additional stored constant related to the spray width, the control circuit 6 determines the aforenoted parameters as a function of the speed and flow rate signals by dividing the fluid flow rate signal by the product of the speed signal and the value of the constant related to the spray width. The resulting signal, connected by appropriate calibration constants, is then displayed on display 7.

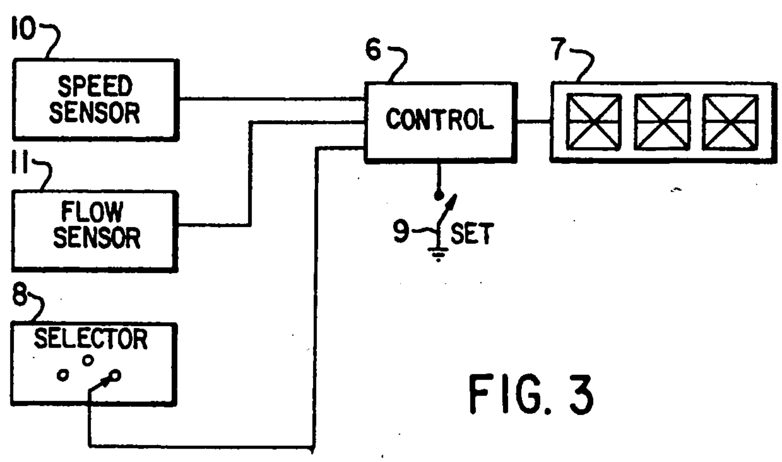

FIG. 3

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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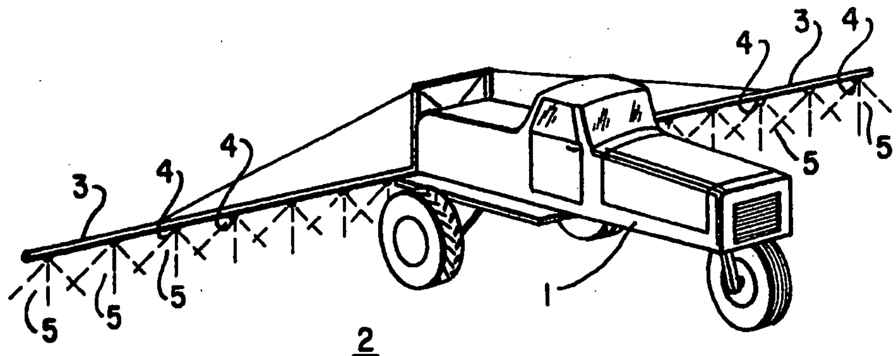


FIG. 1

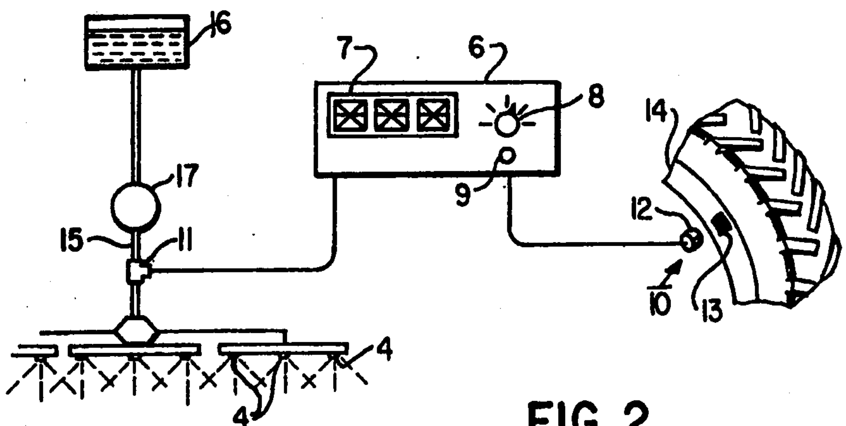


FIG. 2

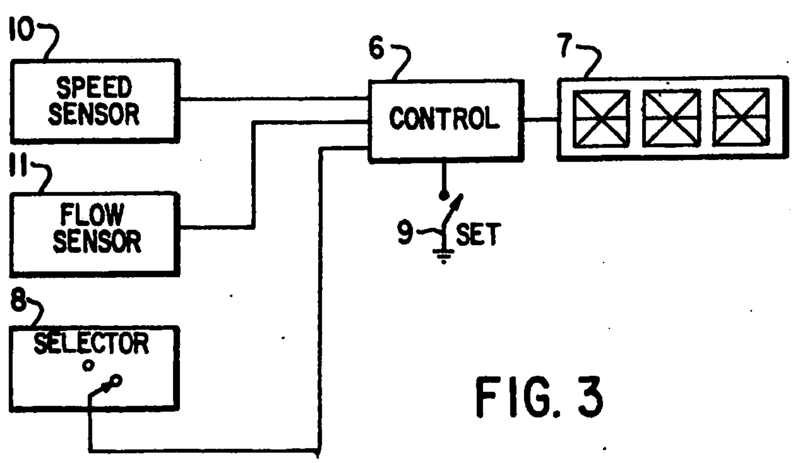


FIG. 3

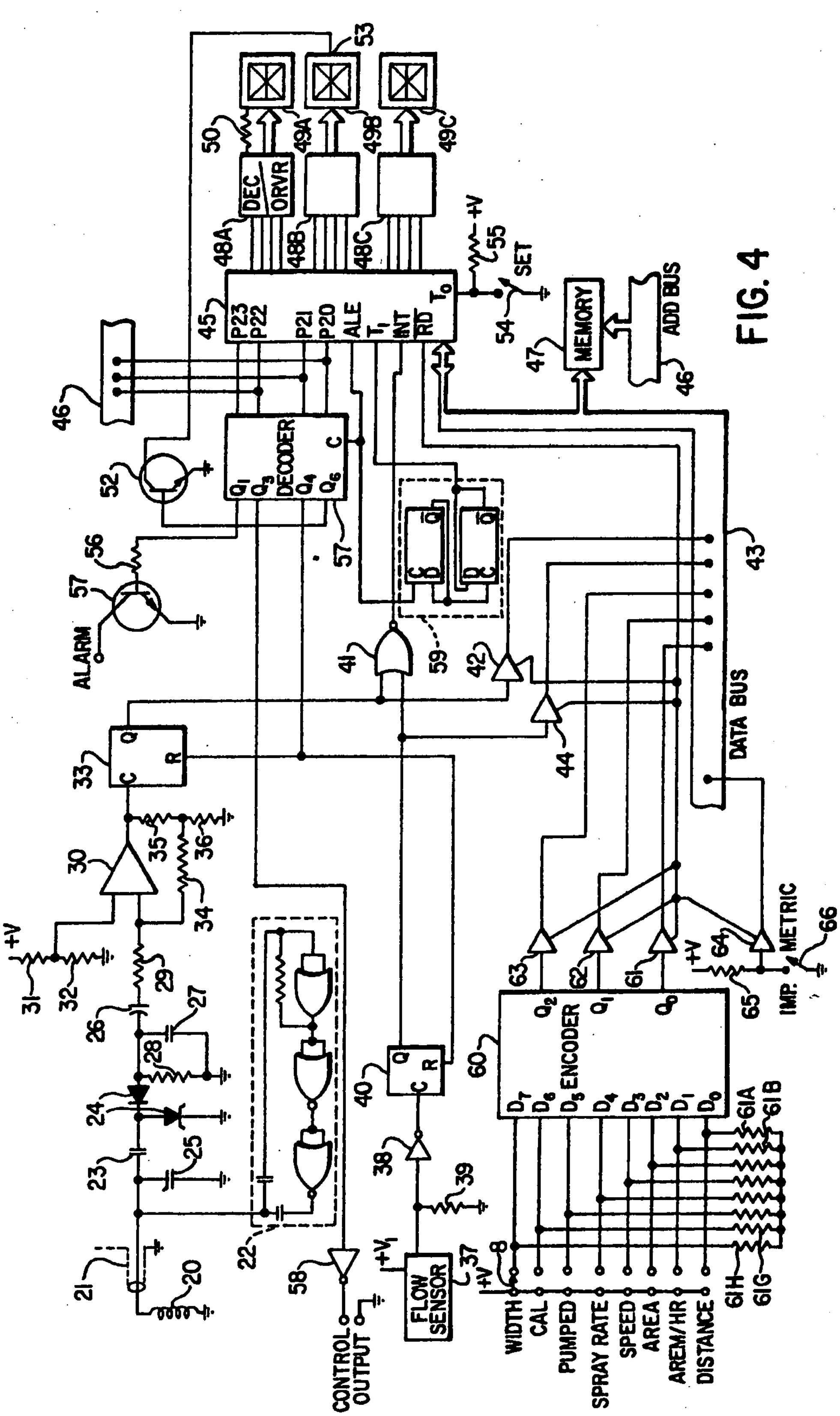

DEC
DRVR
DECODER
ENCODER
MEMORY
ADD BUS
DATA BUS
SET
ALARM
FLOW SENSOR
CONTROL OUTPUT
WIDTH
CAL
PUMPED
SPRAY RATE
SPEED
AREA
AREM/HR
DISTANCE
METRIC
IMP.

FIG. 4

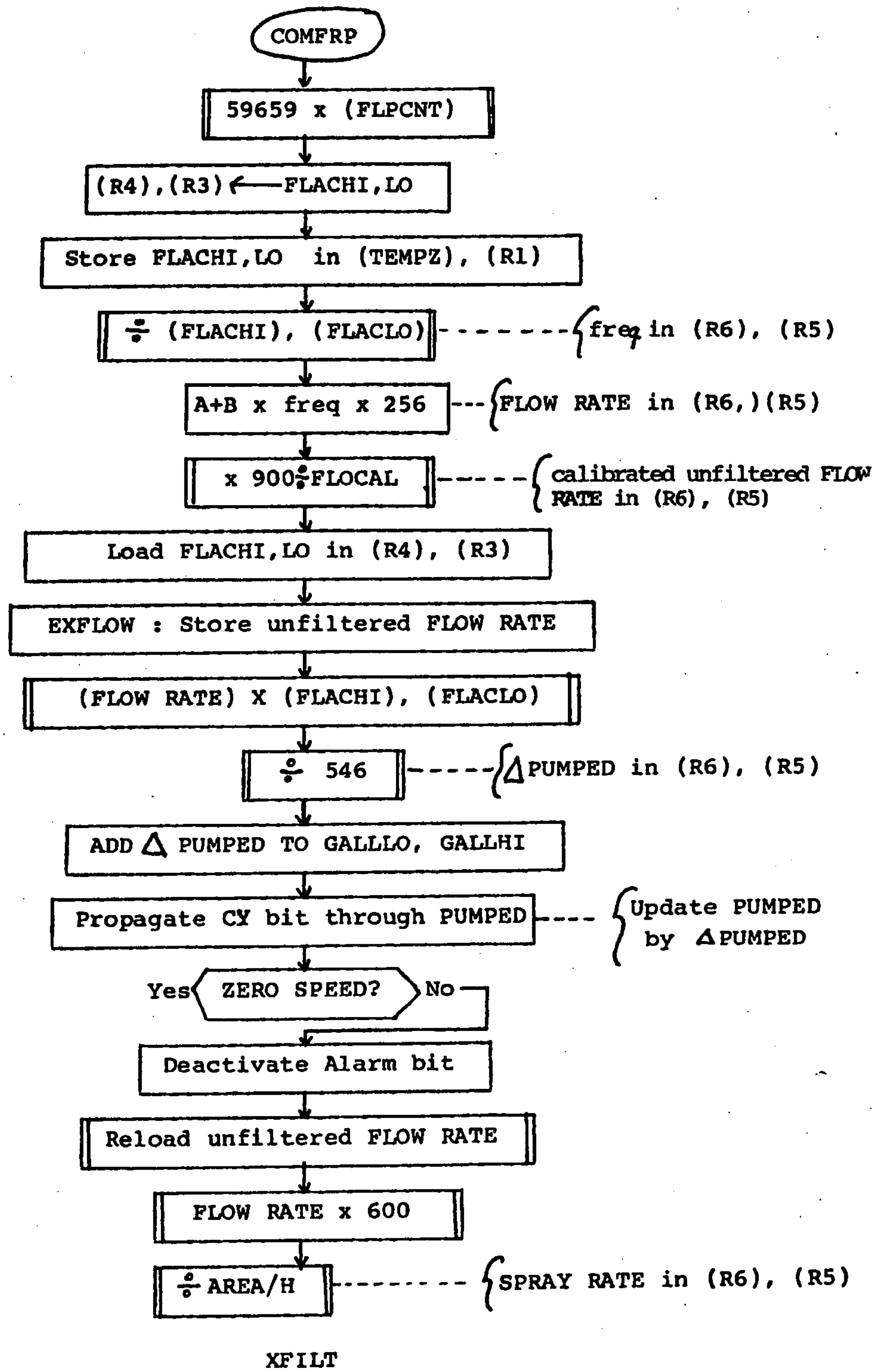

COMFRP
59659 x (FLPCNT)
(R4),(R3) ← FLACHI,LO
Store FLACHI,LO in (TEMPZ), (R1)
÷ (FLACHI), (FLACLO)
freq in (R6), (R5)
A+B x freq x 256
FLOW RATE in (R6,)(R5)
x 900÷FLOCAL
calibrated unfiltered FLOW RATE in (R6), (R5)
Load FLACHI,LO in (R4), (R3)
EXFLOW : Store unfiltered FLOW RATE
(FLOW RATE) X (FLACHI), (FLACLO)
÷ 546
Δ PUMPED in (R6), (R5)
ADD Δ PUMPED TO GALLLO, GALLHI
Propagate CY bit through PUMPED
Update PUMPED by Δ PUMPED
Yes
ZERO SPEED?
No
Deactivate Alarm bit
Reload unfiltered FLOW RATE
FLOW RATE x 600
÷ AREA/H
SPRAY RATE in (R6), (R5)
XFILT

FIG. 5A

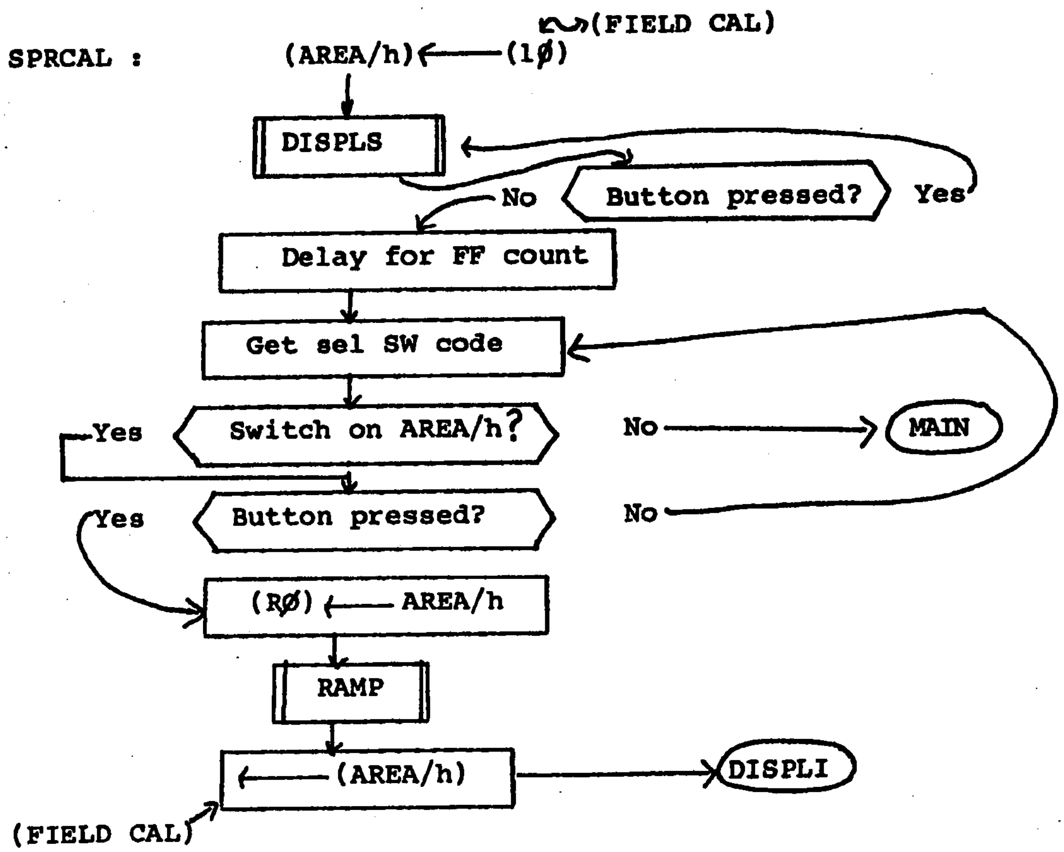

SPRCAL :
(AREA/h) ← (1Ø)
(FIELD CAL)
DISPLS
Button pressed?
Yes
No
Delay for FF count
Get sel SW code
Switch on AREA/h?
Yes
No
MAIN
Button pressed?
Yes
No
(RØ) ← AREA/h
RAMP
← (AREA/h)
DISPLI
(FIELD CAL)

FIG. 5B

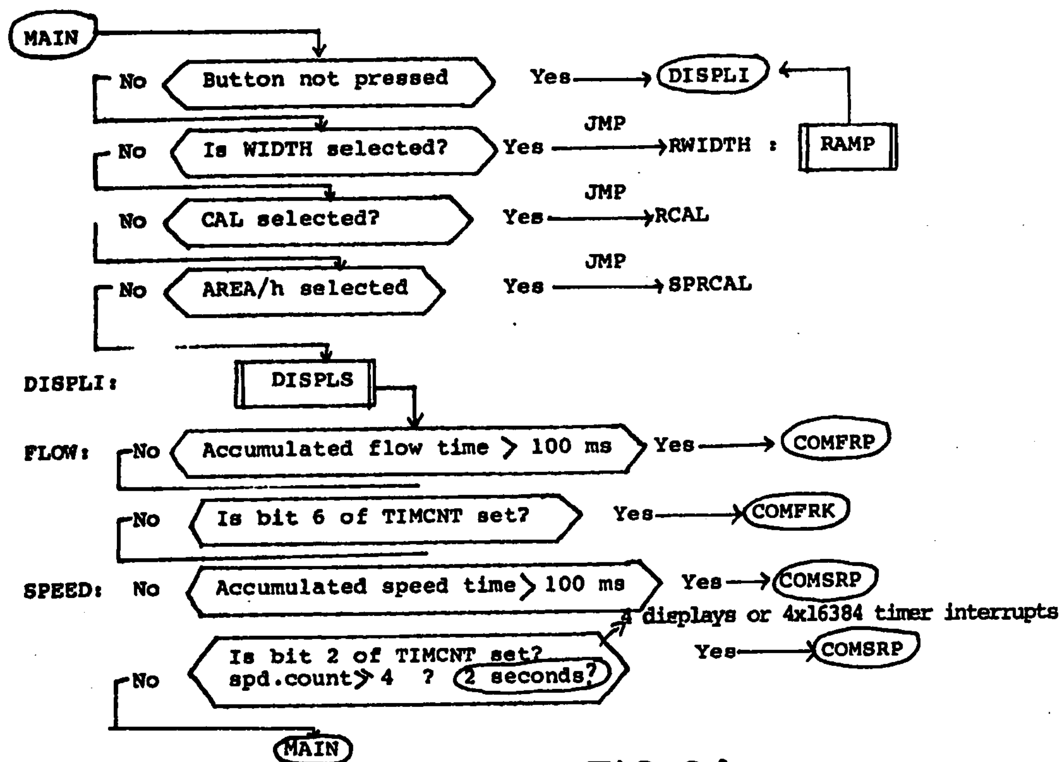

MAIN
No
Button not pressed
Yes
DISPLI
No
Is WIDTH selected?
Yes
JMP
RWIDTH :
RAMP
No
CAL selected?
Yes
JMP
RCAL
No
AREA/h selected
Yes
JMP
SPRCAL
DISPLI:
DISPLS
FLOW:
No
Accumulated flow time > 100 ms
Yes
COMFRP
No
Is bit 6 of TIMCNT set?
Yes
COMFRK
SPEED:
No
Accumulated speed time > 100 ms
Yes
COMSRP
4 displays or 4x16384 timer interrupts
Is bit 2 of TIMCNT set?
spd.count > 4 ? 2 seconds?
Yes
COMSRP
No
MAIN

FIG. 6A

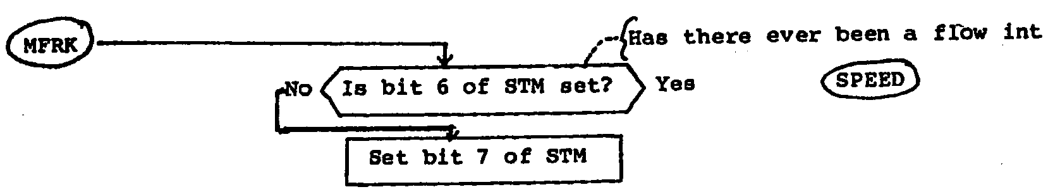

MFRK
Has there ever been a flow int.
No
Is bit 6 of STM set?
Yes
SPEED
Set bit 7 of STM

FIG. 6B

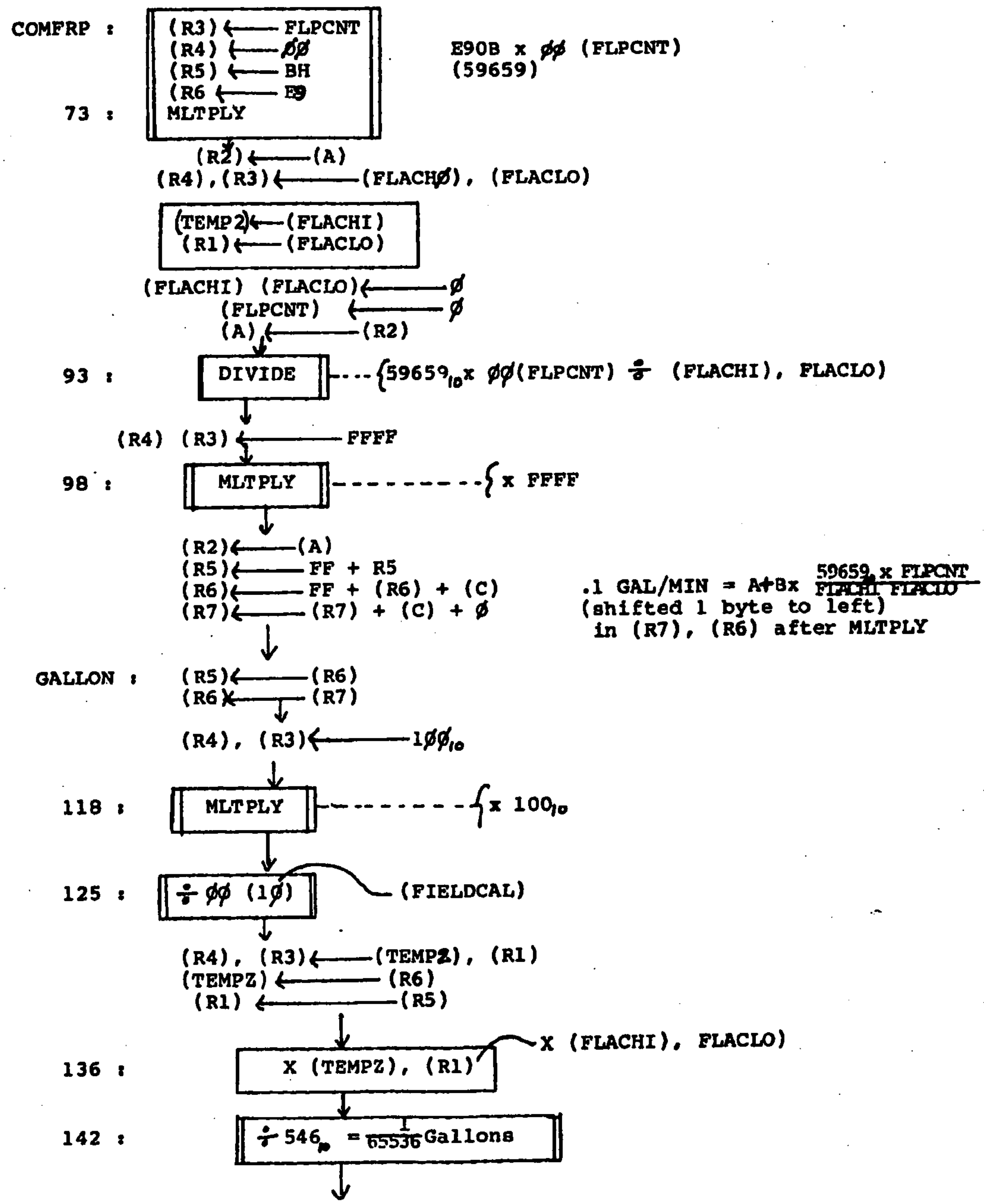
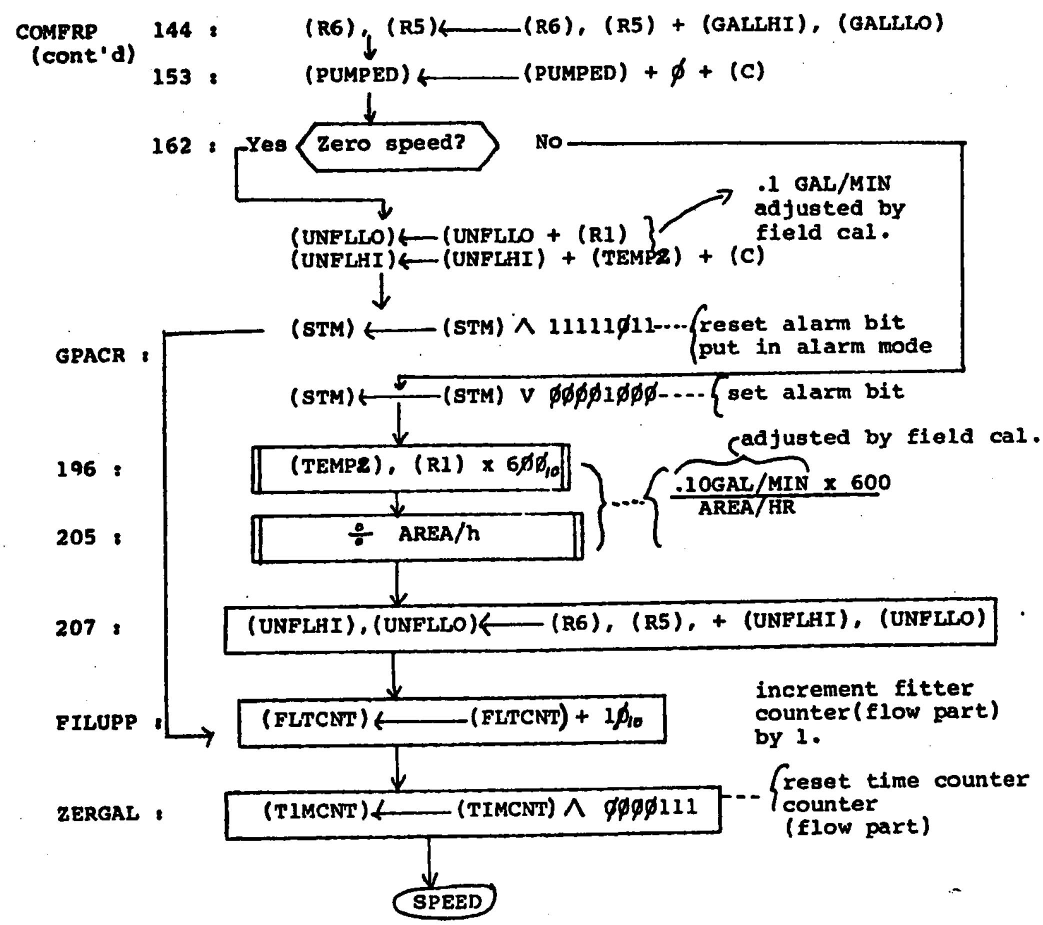

COMFRP :
(R3) ← FLPCNT
(R4) ← ØØ
(R5) ← BH
(R6 ← E9
73 :
MLTPLY
E90B x ØØ (FLPCNT)
(59659)
(R2) ← (A)
(R4), (R3) ← (FLACHØ), (FLACLO)
(TEMP2) ← (FLACHI)
(R1) ← (FLACLO)
(FLACHI) (FLACLO) ← Ø
(FLPCNT) ← Ø
(A) ← (R2)
93 :
DIVIDE
{59659₁₀ x ØØ(FLPCNT) ÷ (FLACHI), FLACLO)
(R4) (R3) ← FFFF
98 :
MLTPLY
{x FFFF
(R2) ← (A)
(R5) ← FF + R5
(R6) ← FF + (R6) + (C)
(R7) ← (R7) + (C) + Ø
.1 GAL/MIN = A+Bx 59659 x FLPCNT / FLACHI FLACLO
(shifted 1 byte to left)
in (R7), (R6) after MLTPLY
GALLON :
(R5) ← (R6)
(R6) ← (R7)
(R4), (R3) ← 1ØØ₁₀
118 :
MLTPLY
{x 100₁₀
125 :
÷ ØØ (1Ø)
(FIELDCAL)
(R4), (R3) ← (TEMP2), (R1)
(TEMPZ) ← (R6)
(R1) ← (R5)
136 :
X (TEMPZ), (R1)
X (FLACHI), FLACLO)
142 :
÷ 546₁₀ = 1/65536 Gallons

FIG. 7A



continue and complete speed related
parameters if enough accumulated time

FIG. 7B

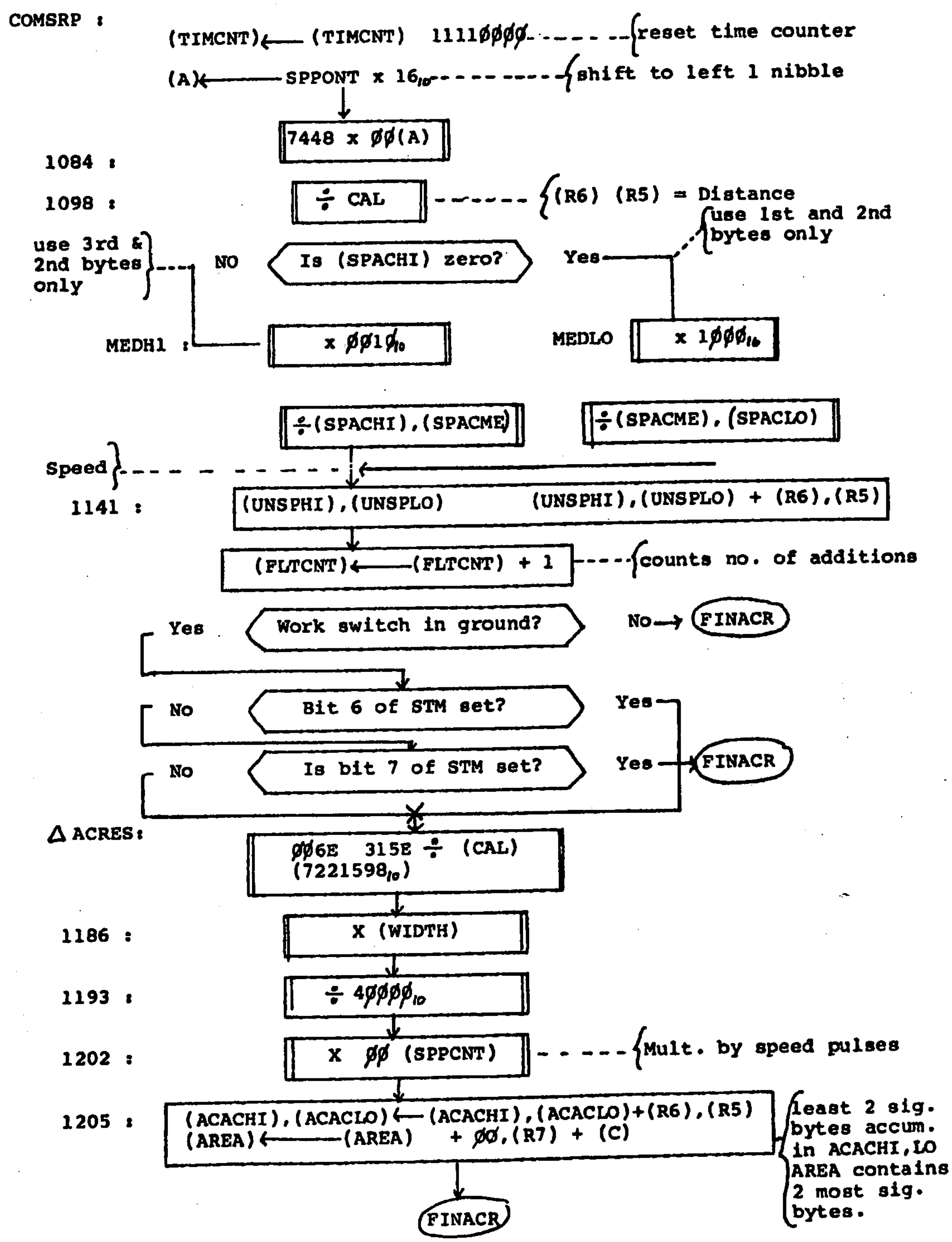

COMSRP :
(TIMCNT) ← (TIMCNT) 1111ØØØØ
reset time counter
(A) ← SPPONT x 16₁₀
shift to left 1 nibble
7448 x ØØ(A)
1084 :
1098 :
÷ CAL
(R6) (R5) = Distance
use 1st and 2nd bytes only
use 3rd & 2nd bytes only
NO
Is (SPACHI) zero?
Yes
MEDH1 :
x ØØ1Ø₁₀
MEDLO
x 1ØØØ₁₆
÷(SPACHI),(SPACME)
÷(SPACME),(SPACLO)
Speed
1141 :
(UNSPHI),(UNSPLO) (UNSPHI),(UNSPLO) + (R6),(R5)
(FLTCNT) ← (FLTCNT) + 1
counts no. of additions
Yes
Work switch in ground?
No → FINACR
No
Bit 6 of STM set?
Yes
No
Is bit 7 of STM set?
Yes → FINACR
Δ ACRES:
ØØ6E 315E ÷ (CAL)
(7221598₁₀)
1186 :
X (WIDTH)
1193 :
÷ 4ØØØØ₁₀
1202 :
X ØØ (SPPCNT)
Mult. by speed pulses
1205 :
(ACACHI),(ACACLO) ← (ACACHI),(ACACLO)+(R6),(R5)
(AREA) ← (AREA) + ØØ,(R7) + (C)
least 2 sig. bytes accum. in ACACHI,LO
AREA contains 2 most sig. bytes.
FINACR

FIG. 8A

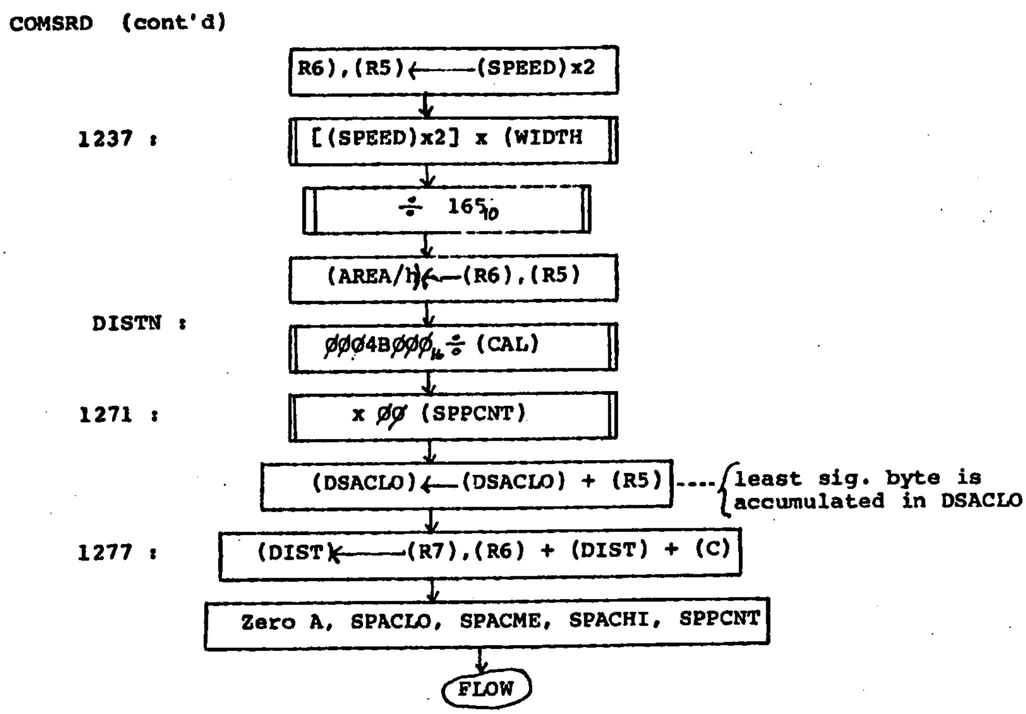

COMSRD (cont'd)
R6),(R5) ← (SPEED)x2
1237 :
[(SPEED)x2] x (WIDTH
÷ 165₁₀
(AREA/h) ← (R6),(R5)
DISTN :
ØØØ4BØØØ₁₆ ÷ (CAL)
1271 :
x ØØ (SPPCNT)
(DSACLO) ← (DSACLO) + (R5)
least sig. byte is accumulated in DSACLO
1277 :
(DIST) ← (R7),(R6) + (DIST) + (C)
Zero A, SPACLO, SPACME, SPACHI, SPPCNT
FLOW

FIG. 8B

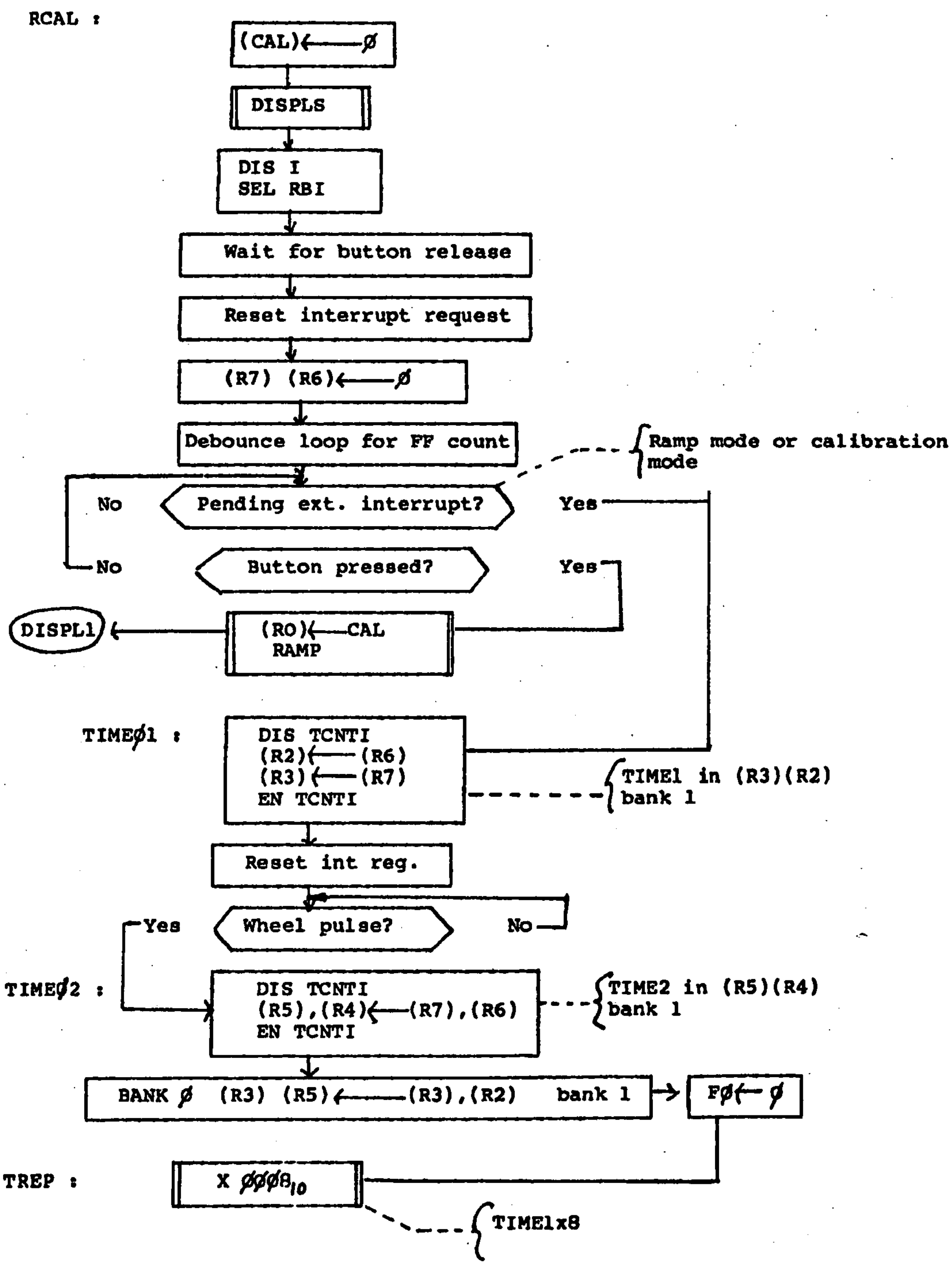

RCAL :
(CAL) ← ø
DISPLS
DIS I
SEL RBI
Wait for button release
Reset interrupt request
(R7) (R6) ← ø
Debounce loop for FF count
Ramp mode or calibration mode
No
Pending ext. interrupt?
Yes
No
Button pressed?
Yes
DISPL1
(RO) ← CAL
RAMP
TIMEø1 :
DIS TCNTI
(R2) ← (R6)
(R3) ← (R7)
EN TCNTI
TIME1 in (R3)(R2) bank 1
Reset int reg.
Yes
Wheel pulse?
No
TIMEø2 :
DIS TCNTI
(R5),(R4) ← (R7),(R6)
EN TCNTI
TIME2 in (R5)(R4) bank 1
BANK ø (R3) (R5) ← (R3),(R2) bank 1
Fø ← ø
TREP :
X øøø8₁₀
TIME1x8

FIG.9A

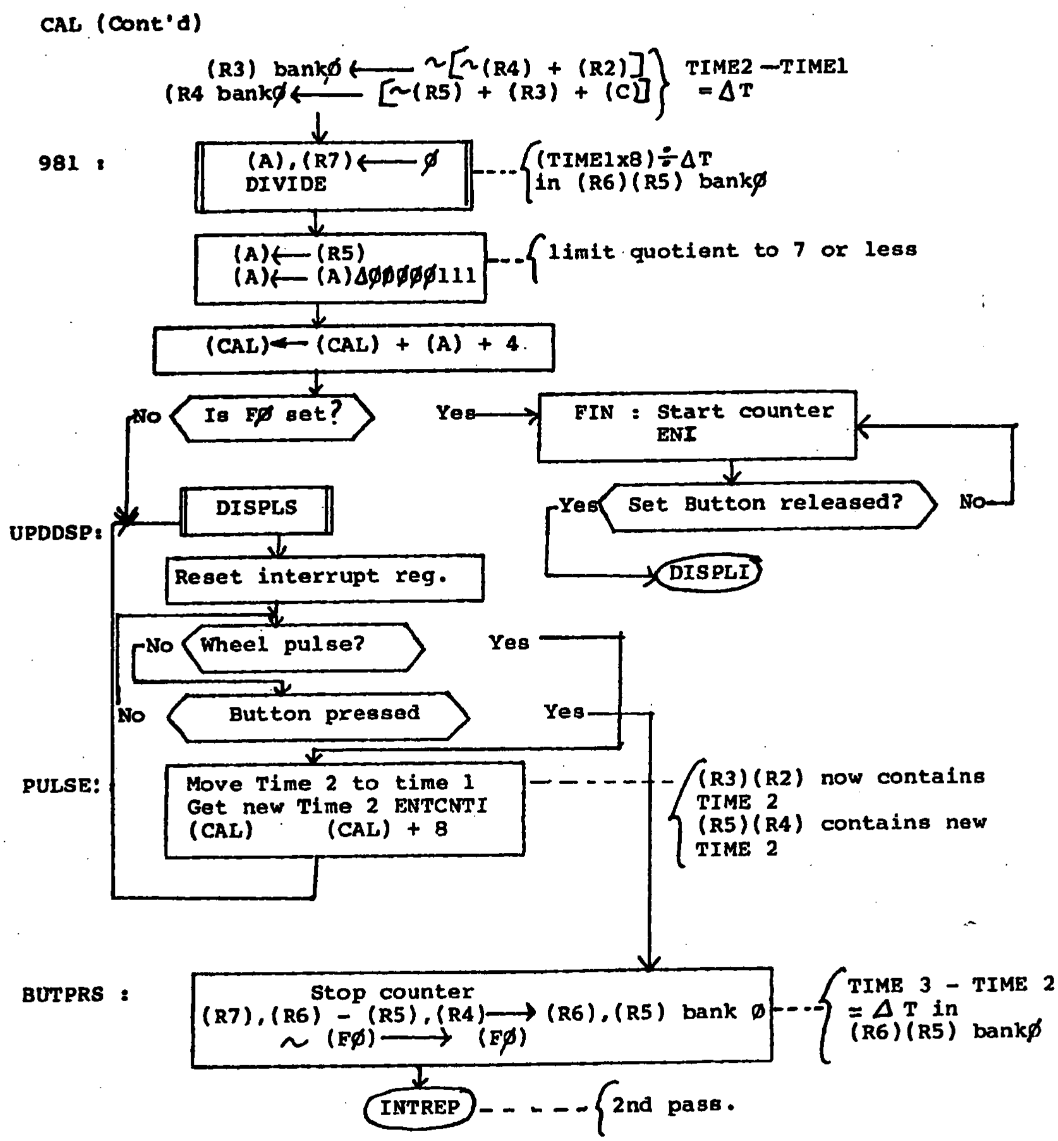

CAL (Cont'd)
(R3) bankØ ← ~[~(R4) + (R2)]
(R4 bankØ ← [~(R5) + (R3) + (C)]
TIME2 — TIME1 = ΔT
981 :
(A),(R7) ← Ø
DIVIDE
(TIME1x8) ÷ ΔT in (R6)(R5) bankØ
(A) ← (R5)
(A) ← (A)ΔØØØØØ111
limit quotient to 7 or less
(CAL) ← (CAL) + (A) + 4
Is FØ set?
No
Yes
FIN : Start counter ENI
Set Button released?
Yes
No
DISPLI
DISPLS
UPDDSP:
Reset interrupt reg.
No
Wheel pulse?
Yes
No
Button pressed
Yes
PULSE:
Move Time 2 to time 1
Get new Time 2 ENTCNTI
(CAL) (CAL) + 8
(R3)(R2) now contains TIME 2
(R5)(R4) contains new TIME 2
BUTPRS :
Stop counter
(R7),(R6) - (R5),(R4) → (R6),(R5) bank Ø
~ (FØ) → (FØ)
TIME 3 - TIME 2 = ΔT in (R6)(R5) bankØ
INTREP
2nd pass.

FIG.9B

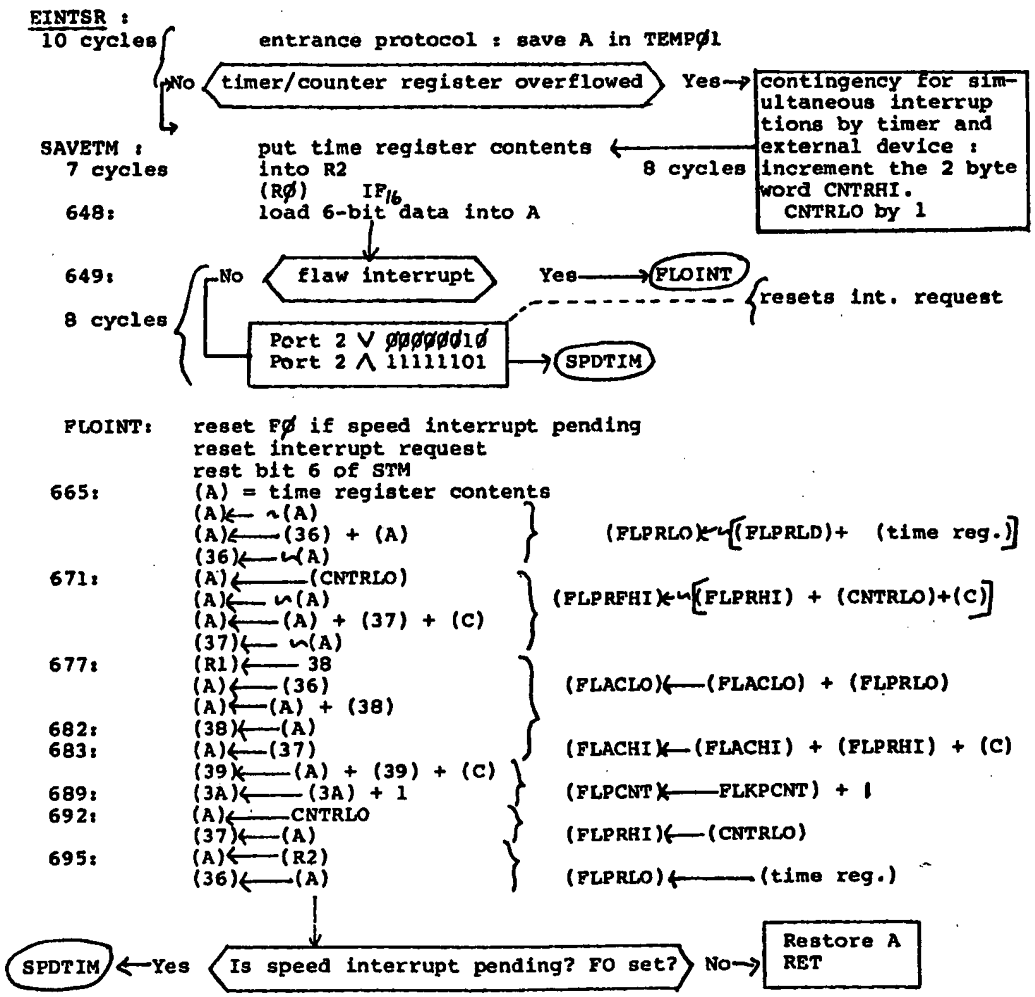

EINTSR :
10 cycles
entrance protocol : save A in TEMPØ1
No
timer/counter register overflowed
Yes
contingency for simultaneous interruptions by timer and external device : increment the 2 byte word CNTRHI. CNTRLO by 1
8 cycles
SAVETM :
7 cycles
put time register contents into R2
(RØ) IF16
648:
load 6-bit data into A
649:
8 cycles
No
flaw interrupt
Yes
FLOINT
resets int. request
Port 2 V ØØØØØØ1Ø
Port 2 Λ 11111101
SPDTIM
FLOINT:
reset FØ if speed interrupt pending
reset interrupt request
rest bit 6 of STM
665:
(A) = time register contents
(A)← ~(A)
(A)←(36) + (A)
(36)← ~(A)
(FLPRLO)←~[(FLPRLD)+ (time reg.)]
671:
(A)←(CNTRLO)
(A)← ~(A)
(A)←(A) + (37) + (C)
(37)← ~(A)
(FLPRFHI)←~[(FLPRHI) + (CNTRLO)+(C)]
677:
(R1)← 38
(A)←(36)
(A)←(A) + (38)
(FLACLO)←(FLACLO) + (FLPRLO)
682:
(38)←(A)
683:
(A)←(37)
(39)←(A) + (39) + (C)
(FLACHI)←(FLACHI) + (FLPRHI) + (C)
689:
(3A)←(3A) + 1
(FLPCNT)←FLKPCNT) + 1
692:
(A)←CNTRLO
(37)←(A)
(FLPRHI)←(CNTRLO)
695:
(A)←(R2)
(36)←(A)
(FLPRLO)←(time reg.)
SPDTIM
Yes
Is speed interrupt pending? FO set?
No
Restore A
RET

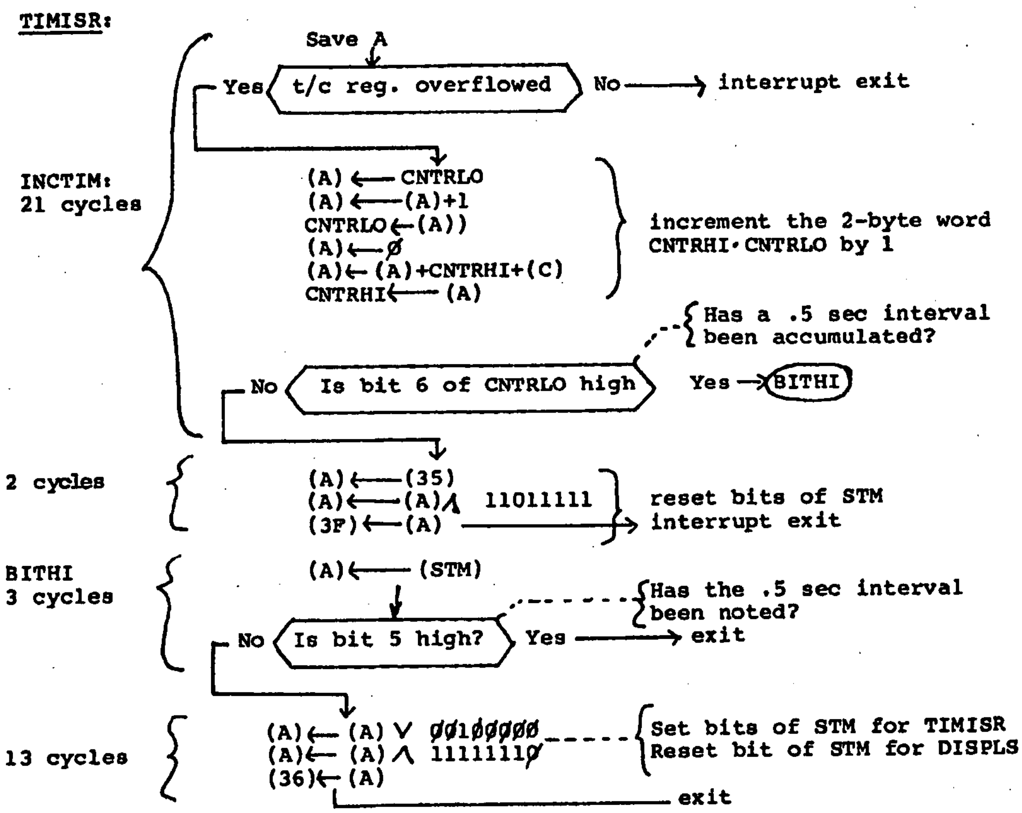
FIG. 10A

EINTSR (Cont'd)

```
SPDTIM :        (SPRLO) <-- ~[~(TIMSAV) + (SPRLO)]            calculate
  42 cycles     (SPRME) <-- ~[~(CNTRLO) + (SPRME) + (C)]       Δ time
                (SPRHI) <-- ~[~(CNTRHI) + (SPRAHI)+ (C)]      for speed
                                                              sensor

 718 :          (SPACLO) <-- (SPACLO) + (SPPRLO               calculate new
                (SPACME) <-- (SPACME) + (SPPRME)              accumulated
                (SPACHI) <-- (SPACHI) + (SPPRHI)              time for speed
                (SPPCNT) <-- (sppcnt) + 1                     sensor

 737 :          (SPPRLD) <-- (TIMSAV)
                (SPPRME) <-- (CNTRLO)
                (SPPRHI) <-- (CNTRHI)

                   Restore A
                   RET
```

10+7+8+42=   67 cyles if no pending timer int.
10+7+8+18+42 = 75 cycles if pending timer int.

FIG. 10B



21+ 12 = 33 cycles if bit 6 of CNTRLO is low.
21+3+6 = 30 cycles if bit 6 high and bit 5 of STM is high.
21+3+13 = 37 cycles if bit 6 high and bit 5 of STM is low.

FIG. 11

SPECIFICATION
Sprayer monitor

This invention relates to agricultural equipment, and particularly to a monitor for a field sprayer, such as a chemical sprayer.

The spray application of chemicals such as fertilizers, pesticides, etc., to the field requires careful control, in order to optimize the rate of application. This is desirable both to minimize cost and to apply the recommended concentration.

The sprayer operator normally calculates the rate of application of the chemical to be sprayed by establishing a flow rate from his mobile storage tank to the spray nozzles, measuring the width of the spray, and establishing a certain rate of speed of the spray vehicle. The field area covered within a given time period allows him to calculate the volume of fluid per unit are which has been applied (e.g. gallons per acre).

While the application rate, with a given vehicle speed, can be calculated before spraying, should the flow rate change during spraying due to a build up of residue in the fluid pipes, should a change in vehicle speed be desired, etc., it would be a difficult and tedious task to maintain a continuous calculation effort in the field, which would be required to ensure that the required application rate is maintained. Consequently apparatus has been made available to the sprayer operator which performs the calculation automatically and provides an indication of certain parameters to him, such as the area covered, the number of gallons per acre applied, etc. In such prior art apparatus flow of the spray fluid is measured as well as the vehicle speed, and knowing the spray width which is utilized, charts or other indicators provide an output indication.

In one such prior art device, in order to measure vehicle speed an electromagnetic detector is used to detect a metallic discontinuity or a magnet applied to a vehicle wheel. The rotation rate of the wheel is converted by the apparatus into vehicle speed. Calibration for the wheel circumference is done by thumb-wheel switch. A water flowmeter provides an electrical signal which is alleged to be proportional to the amount of fluid flowing to the spray heads. This apparatus calculates applied gallons per acre. In another such device, a photosensor is used to sense markings on the vehicle wheel, to determine its rotation rate and thus the speed of the vehicle. Alternatively, an outboard wheel which follows the vehicle is used to determine the ground speed. This apparatus also includes means to synchronize the spray bar pressure with ground speed via a servo control valve.

The sprayer monitors utilizing the above-noted vehicl speed s ns rs all have a deficiency in c mmon, that is, that the rat f application data given to the farmer is determined by a parameter which is not an accurate representati n of the parameter purported to be represented. For exampl ground spe d is determined by the rotation rate of a wheel or the rotati n rate of a shaft. Where the ground is soft or the tire inflation pressure of the tractor or vehicl wheel is low, the vehicle whe l will rotate a greater number of times for a given linear distance than if the inflation pressure were higher or the ground firmer. The chemical flow rate per unit time might then be increased, resulting in wastage of spray fluid.

Where an outboard wheel is used, mud and debris can impede its smooth operation, and it can be subject to bounce, thus reducing its accuracy.

The present invention, on the other hand, allows the sprayer operator to calibrate his vehicle and spray apparatus directly, the calibration constant being stored by the apparatus, thus giving him a substantially improved accuracy of spray application.

The present invention provides the sprayer operator with an accurate measurement of the rate of fluid application, the total volume applied, the true ground speed, the area covered, the spray rate, and the distance travelled. Calibration is controlled at the vehicle driver's seat.

In the present invention the ground speed sensor is a metal detector which detects metal targets or discontinuities on a wheel or on any rotating part which has its speed related to ground speed. A circuit determines the distance travelled as each target passes and the ground speed is computed. Means is further provided to calibrate the ground speed, with tire size, tire pressure and soil compaction effects automatically accounted and compensated for, resulting in a more accurate representation of the ground speed than in the prior art.

The fluid flow rate is determined by a flowmeter in the fluid flow line leading to the spray bar carrying the spray heads. A pulsing signal sent from the flowmeter is proportional to the volume pumped per unit time. The width of the spray line is entered into the apparatus by pushbutton. A digital display provides the output to the operator.

Clearly the application rate is determined by how fast an area is covered and by the quantity of chemical sprayed. The present invention multiplies signal representing the speed and width, and the result is divided into the flow rate to obtain the rate of application of the fluid. All other outputs provided to the operator are obtained from the three measurements noted above, of speed, flow rate and width. Since the width can be determined by actual measurement, and is normally relatively stable, and both flow rate and speed are calibrated by actual tests or by manually inputting constants relating to particular fields, for example, the present apparatus has been found to have considerably improved accuracy over prior art apparatus.

The invention, in general, is a sprayer m nit r f r spray vehicles comprising a sensor f r sensing th speed of the sprayer and f r providing a first signal representative of the speed, a s nsor for sensing the rate of flow f a fluid to be sprayed and for providing a second signal repres ntative f th rate of flow, a mem ry for storing a third signal

representative f the width of the sprayer, a display, and a contr l circuit for r ceiving the signals and for gen rating a display operating signal and applying it to the display, which corresponds to the value of the second signal divided by the product of the first and third signals, representing the volume of fluid sprayed per unit area.

More particularly, the invention is a sprayer monitor for a spray vehicle comprising: a circuit for receiving a speed indication signal comprising a plurality of pulses, the frequency of the pulses being related by a predetermined speed factor signal to the actual speed of the vehicle, a circuit for receiving a fluid flow indication signal comprising a plurality of pulses, the frequency of the pulses being related by a predetermined flow factor signal to the actual spray fluid flow rate, a memory for storing signals representative of the spray width of the sprayer, and said speed and flow factor signals, a display, and a control circuit connected to the display, the receiving circuit and the memory for generating a signal representing a number of speed indication pulses received in a predetermined time and a further signal representing a number of fluid flow indication pulses received in a predetermined time, and for applying the speed factor signal to the signal representing the number of speed indication pulses received in a predetermined time to obtain an actual speed signal, and for applying the flow factor signal to the signal representing the number of fluid flow indication pulses received in a predetermined time to obtain an actual fluid flow rate signal, for multiplying the speed signal and the width signal and for dividing the result into the fluid flow rate signal to obtain a signal representative of the volume of fluid applied per unit area, and for applying the latter signal to the display.

A better understanding of the invention will be obtained by reference to the description of the preferred embodiment of the invention described in detail below and to the following drawings, in which:

Figure 1 is a general view of a tractor with a spray bar attachment with which the present invention is used,

Figure 2 is a general pictorial view of the invention,

Figure 3 is a general block diagram of the invention,

Figure 4 is a logic schematic of the invention, and

Figures 5A, 5B, 6A, 6B, 7A, 7B, 8A, 8B, 9A, 9B, 10A, 10B, and 11 are flow charts depicting how the various signals are handled by the control circuit microprocess r.

Turning now t Figures 1, 2 and 3, a tract r 1 f r carrying the apparatus is shown in a field 2, and has a spray bar 3 attached and extending outwardly on b th sides there f. Spray heads or nozzles 4 are located at regular intervals al ng the spray bar, for spraying the field with a fluid carried by the tractor in a tank (not shown). Th spray regions 5 extending from the spray heads or nozzles define a broad line from one end of the bar at one side of the tractor to the ther nd. As the tractor progresses d wn the field, an area is sprayed defined by the sum of the spray regions (total width) multiplied by the distance travelled by the tractor.

A control 6 is located within the cab of the tractor 1. The control 6 includes an alphanumeric display 7, a selector switch 8 and a "set" pushbutton 9.

Inputs to the control unit 6 are carried via cables extending outside the cab of the tractor, and are comparises of a speed sensor 10 and a fluid flow sensor 11.

The speed sensor 10 is comprised of a metal detector 12, for detecting a one or more metal discontinuities 13 on the wheel 14 of the tractor. A discontinuity which is sensed can be, alternatively, on any rotating or reciprocating member of the tractor which has its rate of rotation or reciprocation a function of the speed of the tractor. The function is determined by field calibration of the present invention as will be described later. Metal detector 12 outputs a pulse each time the aforenoted discontinuity passes across it. In case more than one discontinuity is to be detected, the output pulse rate will be higher, but field calibration will take care the pulse rate interpretations. The speed sensor can also be a photoelectric or other type of sensor.

The flow sensor 11 is also of the type which provides a series of output pulses, the number of pulses in a given time being determined by the rate of fluid flow. Preferably the form of flow sensor which is used is of the type described in Canadian Patent Application Serial No. 344,891 filed February 1, 1980 entitled FLOW RATE SENSOR, invented by Simon OKKERSE and Hugh C. WOOD. In this form of flow sensor, a non-magnetic turbine is inserted into the fluid flow line 15, the flow line carrying the fluid to be sprayed between a tank 6 and the spray heads 4 via a pump 17. The turbine rotates with flow of the fluid to be sprayed, and metallic elements in each paddle of the turbine are detected as they pass by a metal detector. The metal detector is comprised of a coil of wire carrying a.c. current; the presence of metal in each paddle modulates the current which is then detected, converted to a pulse waveform, and is carried to the control unit 6.

Accordingly pulses are applied to the control unit via two separate conductive lines, one carrying pulses at a rate which is a function of speed of the tractor, and the other carrying pulses at a rate which is a function of the flow rate of the fluid in the fluid flow line (which is the volume of fluid per unit time which is sprayed).

The "s t" button 9 is used to input data signals to the contr l unit 6 f r calibrati n purposes. Its operation will be described below.

Th selector switch 8 has a number of positions as foll ws: Width, Cal, Pumped, Spray Rat , Speed, Area, Area/Hour, and Distance.

In rder t calibrate the spe d sensor, th

following functions are perform d. It should be noted that this calibration determines the functional relationship f the puls rate to the actual vehicle speed, and compensates for wheel size, tire pressure, softness of the field and other characteristics of the pulse repetition.

Two stages are driven into the field which is to be worked, e.g. exactly 150 feet apart (in the preferred embodiment). The selector switch 8 is placed in the "cal" position. The tractor is driven past the first stake to the second, at a constant speed, such as 3—5 miles per hour. As the tractor is driven up to the first stake, the "set" button is pressed. As soon as the first stake is passed, the "set" button is released. The control unit 6 applies counting signals to the display 7, which begins displaying sequentially increasing digits as the wheel targets (metal discontinuities) 13 pass the metal detector 12. As the second stake is passed, the set buttom should be pressed and released quickly. This is detected by control unit 6, which stops the counting on the display.

The control unit 6 stores the signal on the display, which is determined at exactly 150 feet. This calibration number is automatically entered into the memory of the control unit, and is used for distance and speed determination.

Accordingly, the calibration constant stored is the number of pulses obtained from the metal detector 12 within a predetermined distance (150 feet in this embodiment) but can be automatically determined to a different base line distance (e.g. 100 feet) by dividing the signals down. In the event that tire pressure was low, there will be a greater number of pulses between the stakes than if the tire pressure was higher. This clearly distinguishes between the above-described prior art devices which merely count the number of pulses of a rotating member, and assume that the number of pulses corresponds to a given distance. Clearly a more accurate distance determination is facilitated using the present invention.

The calibration constant, which appears on the display, can be written down for future input when using the same equipment in the same field, assuming that the tire pressure is the same. This can be applied by selecting the "Cal" input position, and pressing the set button until the same number is obtained as in the field calibration.

Typically, if the loaded tire radius is 11-1/4 inches, and four targets or discontinuities are on the wheel for detection by metal detector 12, the calibration constant on the display will be about 815. It has been found that different calibration values will be obtained from soft and hard ground, from field conditions to road conditions, and with different tire pressures. That these calibrations are considerably different illustrates the improvement in accuracy obtained with the present invention from prior art structures.

The spray width should be set in the control unit 6. Th s lect r 8 is turned to the "Width" positi n, and the set button 9 is depr ssed and held. The display 7 begins increasing from z ro toward the required width. At the required width, the set button is released. In case the correct width value has been overshot, the set button is depressed again, and the count begins decreasing. As soon as the correct width is located, the set button is released. Depression of the set button again increases the count. In this manner the procedure can be repeated until the proper value is obtained. This value is stored in the control unit memory.

The number on the display can of course be in decimal feet, or, if the apparatus is calibrated or switchable to a metric scale, the width would be in decimal meters.

The flow sensor 11 can now be calibrated. The selector switch should be switched to the Area/Hour position, and the set button depressed for about one second. The set button should then be released and pressed again, and held until the value 10.0 is displayed. The value can of course can be increased or decreased as described above with respect to calibration of the spray width.

The selector switch is then placed in the Pumped position, and the set button is pressed to enter zeros.

The tank is then filled and pumped out at the flow rate intended to be used in the actual spraying, the selector switch being moved to Spray Rate. When the tank is empty, the selector switch 8 should be placed in the Pumped position, and the displayed value should be compared with the measured quantity of liquid actually pumped.

The new calibration constant is 10.0 × value displayed on the monitor divided by the actual volume pumped.

The new calibration constant should then be entered into the control unit in the Area/Hour position, replacing the value 10.0 with the new calibration constant.

The amount of fluid which is actually pumped and the actual ground speed can thus be accurately calibrated in the present invention, and affords substantial advantages over prior art devices, particularly when the fluid has unusual viscosity (e.g. liquid mixed with seed), is applied with changing pump rates, must be used with changing field conditions, tire pressures, etc. Where the apparatus has been calibrated for different portions of a field which exhibits widely varying (but predetermined) field conditions, the apparatus can be quickly manually recalibrated, and provide an accurate representation of the parameters.

With the selector switched into the Pumped position, the total volume of liquid which has passed through the flow meter is displayed. Each time a unit (i.e. gallon or liter) of the chemical passes thr ugh the flow m ter, th display increases by one and a decimal similar unit. With th sel ctor switch in the Spray Rate position, the application rate for the chemical in e.g. gallons per acre is displayed. With the select r switch set t Speed, the true ground speed in e.g. tenths of miles per hour is display d.

When the spray r is operat d, the total area

worked is continuously added up. When the selector switch is set t Area, the total area worked, e.g. in acres is displayed. Wh n th chemical fluid stops flowing, and the flow meter stops sending pulses, and the in the control unit accumulation of the sum of the acres sprayed, is automatically shut off.

With the selector switch set to Area/Hour, the true current rate of working the field is displayed, e.g. in acres per hour. With the selector switch is set to Distance, the display shows the distance in feet that the implement has moved.

Of course the control unit 6 can be calibrated in either imperial or metric units; conversion constants to km/hour for speed, litres per hectare for spray rate, hectares for area, etc., can be stored in the apparatus. Indeed, an external switch for switching between the imperial and metric forms of measurement can be utilized (not shown).

Turning now to Figure 4, a schematic of the invention is shown.

The speed pickup described earlier, comprised of a metal detector, includes a coil 20 mounted adjacent a metal extension or discontinuity on a wheel or rotating member of the tractor, the rotation rate (or reciprocation rate) of which is related to its assumed speed. The coil 20 is connected via a shielded cable 21 to the control unit.

In the control unit, an oscillator 22 applies a signal, such as at a 20 kilohertz frequency, to coil 20. The coil 20 carries the signal, and when a metal discontinuity passes in the field, modulates the signal. The resulting modulated signal is A.C. coupled via capacitor 23 to detector diodes 24. Noise spikes or the like are bypassed to ground via capacitor 25.

Following detection in diodes 24, the detected modulation signal is A.C. coupled via capacitor 26 (after being lowpass filtered by capacitor 27 in parallel with resistor 28 bypassing the signal-carrying circuit to ground), is applied via resistor 29 to one input of comparator 30. The other input of comparator 30 is connected to the tap of a resistive voltage divider comprising resistors 31 and 32 connected between a source of potential +V and ground. Pulse signals detected from the modulated oscillator signal, which modulation was caused by discontinuities detected in coil 20, have their amplitudes compared with a threshold voltage in order to avoid operation of the following circuitry by noise pulses. The resulting output signal from comparator 30 is applied to the clock input of flip flop 33. The gain of comparator 30 is controlled by resistor 34, which is connected from the first-noted input of comparator 30 to the junction between the two resistors 35 and 36 which are connected in seri s between the output of comparator 30 and ground.

The output signal at output Q of flip flop 33 is a square wav , with th number of pulses p r minute being a function of the vehicl speed.

The fl w of fluid to be spray d is detected in flow sensor 37, which produces utput puls s at a rate which is a function of the rat of fluid fl w to the vehicle spray nozzl s. Th flow s ns r can b the typ describ d arlier, i.e. th type d scribed in th aforenoted copending pat nt application, or some other flow sensor which provides a pulse signal which has a rate which is a function of the flow rate of the fluid which is measured. Its output signal is applied to inverting buffer 38 (its input also being connected to ground via a line-impedance determining resistor 29), and its output is connected to the clock C input of flip flop 40. The output signal at the Q output of flip flop 40 thus is a series of pulses having a rate which is a function of the flow rate of the fluid passing to the vehicle spray nozzles.

It should be noted that the pulses applied to flip flops 33 and 40 are inverted. Thus at the rising trailing edge of each of the pulses, the flip flops are clocked, and the Q output goes high.

The output signal of flip flop 33 is applied to one input of NOR gate 41, and also to the input of a tristate buffer 42. The output of tristate buffer 42 is connected to one lead of data bus 43.

The output signal of flip flop 40 is connected to the second input of NOR gate 41, and also to the input of tristate gate 44, the output of which is connected to a another lead of data bus 43.

With pulses being received from the vehicle speed sensor or flowsensor 37, output pulses are applied to NOR gate 41, which generates an output pulse signal which is applied to the interrupt input INT of a microprocessor 45. The data bus 43 is of course connected to microprocessor 45, as is an address bus 46, a control bus, etc., in a manner well known to those skilled in the art. Memory 47 is also connected to microprocessor 45 via the bus system.

Microprocessor 45 is also connected to a plurality of decoder/drivers 48a, 48b and 48c, the outputs of which are connected to corresponding alphanumeric display elements 49a, 49b and 49c. The connections are shown as buses, but of course the outputs of the decoder/drivers are connected to the display element terminals via resistors, a representative resistor 50 being shown.

Microprocessor 45 has a plurality of output P20—P23 which are connected to inputs of a a decoder 51. An output Q6 of decoder 51 is connected to the base of NPN transistor 52, the collector of which is connected to the decimal point input 53 of display element 49b.

The timing reset input To of microprocessor 45 is connected to ground via SET pushbutton 54 (which corresponds to switch 9, Figs. 2 and 3), and also to a source of potential +V via resistor 55.

It is preferred (but not mandatory) that the microprocessor and ancillary memories, etc., should b th 8000 family type available from Intel Corporation, such as 8035L, 8039/8048, 8049. A full description of the structure, operation and manner of programming this microprocessor is availabl in many microcomputer manuals, such as MICROCOMPUTER PRIMER, by M. Waite and M. Parde , published by Howard W. Sams and

Company, Inc., 1976, and from Intel Corporation. A detailed description thereof is th r for believed to be within th skill of a pers n skilled in the art, and since a detailed description thereof would be redundant and unnecessary, it will not be repeated here.

Returning now to decoder 51, a further output Q1 is connected via resistor 56 to the base of NPN transistor 57. The collector of transistor 57 is connected to an alarm terminal, its emitter being connected to ground. The alarm can be used to alert the operator if the spray rate is being measured by no pulses are being received from the flow sensor, for example.

An output Q3 of decoder 51 is connected via an inverting buffer 58 to a controlled output terminal, which has a return lead to ground. This terminal can be used for switching on the spray pump, for example.

Another output Q4 of decoder 51 is connected to the reset inputs R of flip flops 33 and 40.

A clock source, preferably comprising a 3.579 megahertz crystal oscillator (not shown) is connected in a conventional manner to microprocessor 45. An internal clock divider in the microprocessor applies a signal at 1/15th this rate to its ALE output, which signal is applied to the clock input C of decoder 51, and also to the memory address decoders (not shown). The ALE output is also connected to the clock input of a 1/4 divider 59, the output of which is connected to a T1 counter input of microprocessor 45.

The selector switch 8 is connected between a source of potential +V to one out of 8 inputs D0—D7 of a priority encoder 60. Each of the inputs D0—D7 is connected via a resistor 61a, 61b, . . . 61h to ground. Thus ground potential is applied via one of resistors 61a—61b to each of the inputs D0—D7 unless switch 8 is switched to one of the inputs. Potential +V is applied to the encoder input to which switch 8 is connected.

The switch positions are preferably allocated and labelled as shown: WIDTH, CAL, PUMPED, SPRAY RATE, SPEED, AREA, AREA/HOUR, and DISTANCE.

The outputs Q0—Q2 of encoder 60 are connected via tristate gates 61, 62 and 63 to various leads of data bus 43.

A further tristate gate 64 has its input connected to manual switch 66, which is connected from source of potential +V via resistor 65 to ground. The output of tristate gate 64 is connected to one of the leads of data bus 43. The input of gate 64 is at high potential unless switch 66 is closed, which forces the input of gate 64 to low potential. Switch 66 is used as an enabling input for metric or imperial c nversion in microprocessor 45.

All of the enabl inputs of tristate gates 42, 44 and 61—64 are connected together, and to th read $\overline{RD}$ output of micropr cessor 45. The signals applied to the gates are thus read when the $\overline{RD}$ output goes high.

The microprocessor multipli s signals representing the speed of the vehicl and the spray width, and divides the result into a signal representing th fluid flow rat t obtain the rat f applicati n to th fluid. Assuming that a signal representing the spray width has been stored in the microprocessor memory using the set switch 54, signals representing the speed and flow rate must be received.

As noted earlier, pulses at a rate representative of the vehicle speed are output from flip flop 33 and are applied to one input of NOR gate 41 and to tristate gate 42 and pulses at a rate representative of the flow or fluid are output from flip flop 40 to the second input of NOR gate 41, and to the input of tristate gate 44. With the input of a pulse from either of flip flops 33 and 40, an interrupt signal is generated to microprocessor 45.

Microprocessor 45 in response generates a read signal on the $\overline{RD}$ output, enabling all of tristate gates 42, 44, and 61—64.

Assuming that the spray rate is to be displayed, switch 8 had been positioned so that input D4 of encoder 60 is connected to potential source +V. The resulting encoded output signal of encoder 60 is thus applied to data bus 43 via tristate gates 61, 62 and 63, when the read enable signal on the $\overline{RD}$ lead is received. The microprocessor is thus informed that the program for displaying the spray rate should be accessed.

At the same time, the pulse applied to one of the two inputs of tristate gates 42 and 44 is applied to data bus 43. It should be noted that a signal on the microprocessor $\overline{RD}$ output will not occur if pulses are present at the output of flip flops 33 and 40 simultaneously, since NOR gate 41 will be inhibited; the microprocessor would be confused as to which source count to increment.

In the case of a single input pulse to NOR gate 41, an output signal from only one of tristate gates 42 and 44 will be present, and is input via data bus 43 to microprocessor 45. Having determined which lead of data bus 43 carries the input pulse signal, the microprocessor establishes whether the pulse is a speed pulse or a flow rate pulse.

It was noted earlier that a signal appears on the ALE lead of microprocessor 45 which is 1/15th the rate of the crystal oscillator, i.e. 1/15th of 3.579 megahertz. This reduced clock rate is further reduced in a 1/4 divider 59, the output of which is applied to input T1 of microprocessor 45, i.e., at 59,650 pulses per second. This further reduced rate is counted with internal counters in microprocessor 45.

When an interrupt arrives from the output of NOR gate 41, the internal clock count of the count from input T1 is recorded. The successive clock pulse counts are also subtracted, to obtain rate variations.

Assuming that in 150 feet there are 185 speed interruptions,i.e. 5.4 interruptions per second, the internal clock counts about 11,00 pulses on the T1 input between speed pulses. This value is internally converted to a speed rate, th signals being decoded in decoder drivers 48a, 48b, and 48c and are supplied to display segments 49a, 49b and 49c wh n the select r switch 8 is

switched to the D3 input of decoder 60.

Pulses from th flow sensor 37 occur at a much fast r rate, typically between 10 pulses per second and 5,000 pulses per second. Microprocessor 45 recognizes the source of pulses as described above, using the count reached of the pulses on lead T1 to establish the speed and flow rate value signals used in the aforenoted calculation.

When the microprocessor determines which source, either the speed or flow sensor from which the input pulses are being received, it outputs a signal to decoder 51, which applies a signal to output Q4, which resets both flip flops 33 and 40. The next pulse which is received by those flip flops thus outputs on their Q outputs.

The microprocessor is caused to accept and store the spray width calibration when switch 8 is connected to input D7 of encoder 60. An encoded output signal from tristate gates 61—63 is applied to data bus 43, which causes the micrprocessor to accept count input signals on lead T1, when pushbutton 54 if closed, applying an enable signal to input T0. The count signal is displayed on display elements 49a, 49b and 49c. Successive closures of switch 54 cause the count sum in microprocessor 45 successively to increase or decrease, the result being automatically stored in a memory location allocated to the width parameter.

When the switch 8 is set to input D6 of encoder 60, the microprocessor is caused to receive input pulses from the speed coil 20 via flip flop 33 and store the resulting count, as long as the set pushbutton 54 is open. Therefore when calibrating the apparatus, the set pushbutton 54 is closed as the vehicle is driven past a first calibration post, and immediately released. As soon as the set pushbutton is open, pulses from flip flop 33 are applied via data bus 43 to the microprocessor, and are counted, and a count displayed on display 53. As soon as the second calibration post is reached, the set 54 pushbutton is momentarily depressed, and the sum of the counts is retained in memory as the speed calibration factor.

When switch 8 is switched to contact D5 input of encoder 60, the circuit operates similarly, except that pulses from the flow sensor 37 and flip flop 40 are accepted.

Switch 8 being closed to inputs D4, D3, D2, D1 or D0 of encoder 60, enables the microprocessor 45 to display the spray rate, speed, area, area per hour, and distance respectively on display elements 49a, 49b and 49c.

A preferred algorithm for the firmware used to operate the microprocessor is described below, with reference to Figures 5A—11. Of course other algorithms may be designed. The param ters ref rred to are of course names of corresponding signals. Figures 5A and 5B ar a flow chart f th signal logic in the micr pr cessor for computing and displaying and calibrating the flow rate (area per hour), and is described below. This is a subroutin of a master flow chart, and is described first for the purpose of bett r illustrating the invention. These figures ar intended to f rm an appendix to the specification, rather than f rming illustrating figures of the structure of the invention.

It was noted earlier that the bit rate input to input T1 of microprocessor 45 is 59,659 PPS. A signal representing this number, representing the period between successive timer pulses, is multiplied in a first step by the count of the flow rate pulses between interrupts.

Thus, the accumulated flow time between the last (R3) and present (R4) interrupts is accumulated as the values FLACHI,LO, which is stored in memory locations TEMP2 and R1.

In the next step, the accumulated flow pulse count is divided by the accumulated actual time since the last calculation (counting pulses). This gives the number of pulses per second.

In order to determine the number of gallons per minute, the flow rate A offset at which the flow meter starts to rotate (a constant) is added to the slope of the linear characteristic curve of the flow rate sensor (Bx). Bx is determined experimentally, and for the flow rate sensor described in the aforenoted patent application, is the frequency ×256. Accordingly in this calculation the number of pulses per second is converted into a flow rate in gallons per minute, the correlation having been determined experimentally. This value is stored in memory locations R6, and R5.

This flow rate is multiplied by a number, the number 900 being used as a first approximation, and divided by a flow calibration value FLOCAL, which is entered by the operator. The result is stored as a flow rate value EXFLOW.

The flow rate EXFLOW is multiplied by FLACHI or FLACHO, and divided by a constant (546) to convert the values to gallons (or a different constant to convert the value to litres).

This results in the value DPUMPED, a charge in the amount pumped, being stored at R6 and R5.

DPUMPED is then added GALLLO, or GALLHI (gallons low of gallons high), the carry bit being then propagated through the value PUMPED, the amount of spray which has been pumped. Pumped is then updated by the change in the amount pumped DPUMPED.

If the speed of the vehicle is 0, the time flow rate per unit time is displayed alternatively with a code indicating that it is a timed flow rate rather than an area flow rate, e.g., an audible alarm is activated as described earlier.

If the speed of the vehicle is not 0, the alarm bit is deactivated, FLOW RATE is reladed, multiplied by 600 (converting it into 10th of a gallon per acre), the resulting value is divided by acres per hour, resulting in a spray rate value stored at R6 and R5.

The signal is then applied through a low pass filter to rem ve ripple, i.e., a time average is implemented over two to three s conds, rath r than t 100 milliseconds. The area sprayed per hour is then displayed.

Turning t Figure 5B, the spray rate calibration subroutine SPRCAL is described below.

If the set button is pushed, th display is

incremented. However if it is not, after a delay for the input flip fl p count r trieval, the selecti n switch c d is accessed, and a determination is made as to whether the switch is switched to Area/Hour. If it is not, the microprocessor is returned to the main program (to be described later).

If the selection switch is on Area/Hour, a determination is made as to whether the set button is pushed (closed). If the pushbutton has been released, the routine again returns to determine the selected switch code, and the subroutine is returned to the main program as described above.

However, if the set button is pushed, the area per hour value is established by counting subroutine RAMP, by which the display is incremented under control of the set button, and the value stored for the Area/Hour is that shown in the display.

Turning to Figures 6A and 6B, a flow chart for the main program is shown.

The microprocessor first determines whether the set button has been closed. If it is closed, then a Ramp subroutine causes the display to increment progressively until the set button is open.

If the set button is not closed, a determination is made whether the select switch is to the width position. If it is, the RWIDTH sub-routine is entered, by which the value on the display, established by the RAMP program, is entered into a predetermined memory location.

If the set button is not closed, the determination is made whether the CAL position has been selected. If so, the sub-routine RCAL is entered, under control of which the distance calibration is made, as described earlier.

If the set button is not closed, a determination is made as to whether the Area/Hour position has been selected. If so, the sprayer calibration SPRCAL sub-routine is entered, which has been described earlier with respect to Figure 5B. If not, a display is made as to what is stored in other selected dedicated memory registers as follows.

A determination is made as to whether the accumulated flow time is greater than 100 milliseconds. If so, then the sub-routine COMFRP is entered, the one described with reference to Figure 5A. If the accumulated flow time is 100 milliseconds or less, a determination is made as to whether bit 6 of the time counter TIMCNT is set. If so, two seconds has passed with no interrupt, and there is a forced answer with a zero result. The subroutine COMFRK, which forces a calculation of the flow, is entered.

If the answer is no, a determination is made as to whether the accumulated speed time without an int rrupt is gr ater than 100 milliseconds. If y s, the speed r lated parameters ar calculated by a calling up of sub-routine COMSRP. If not, a determination is made as to whether bit 2 of the time c unt r TIMCNT is set, and a forced calculati n is mad if th r is no interrupt for tw seconds. The subroutine COMSRP noted above is therefore entered. If the answer is no, the main program is re ntered as noted above.

The flow related parameters subroutin COMFRP flow chart is shown in Figure 6B. A determination is made as to whether bit 6 of the station transfer memory STM byte is set (i.e., has there ever been a flow interrupt). If it is true, then the speed is calculated and displayed. If it is false, then bit 7 of the station transfer memory byte is set (i.e., is the flow meter operating?). If not, the accumulation of acres (area) is stopped, and the speed is displayed.

The sub-routine COMFRK is looped continuously until an interrupt is received. Then the clock is read to see whether the interrupt is a speed or flow interrupt. The flip flops are reset and another interrupt is awaited. After 100 milliseconds the count is established. Once the time per given number of accumulated interrupts is established, after 100 milliseconds, the calculation routine is then entered whereupon the average speed is calculated, the flow rate, area, distance, volume, etc., i.e. each time 100 milliseconds is interrupted.

The flow chart of subroutine COMFRP is shown in Figures 7A and 7B, the flow chart of subroutine COMSRP is shown in Figures 8A and 8B, the flow chart of subroutine RCAL is shown in Figures 9A and 9B, and numerous other subroutines called up such as EINTSR and TIMISR are shown in Figures 10A, 10B and 11A respectively. Having described the programs COMFRP, MAIN, and COMFRK in detail, it is believed that the flow charts of the remaining subroutines are inherently clear, and need only be followed by a person skilled in the art of microprocessors understanding this invention.

The sprayer monitor described herein provides for farmers and sprayer operators a considerably improved facility to apply spray chemicals to fields and roads with improved accuracy of application, and improved economy of application, since the precision of application is not left to uncalibrated assumed parameters, as in the prior art. The present apparatus provides means for calibration to actual field conditions.

Persons skilled in the art understanding this invention may now conceive of other embodiments or variations thereo. All are considered within the sphere and scope of the invention as defined in the claims appended hereto.

CLAIMS

1. A sprayer monitor for a spray vehicle comprising:

(a) means for receiving a speed indication signal comprising a plurality of pulses, the frequency of the pulses being related by a pred t rmined speed factor signal to th actual speed of the vehicle.

(b) means for receiving a fluid flow indication signal comprising a plurality of pulses, the frequ ncy of the pulses being related by a predetermined flow factor signal to th actual

spray fluid flow rate.

(c) means f r st ring signals representativ of th spray width of the sprayer, and said speed and flow factor signals,

(d) a display, and

(e) control means connected to the display, the receiving means and the storing means for generating a signal representing a number of speed indication pulses received in a predetermined time and a further signal representing a number of fluid flow indication pulses received in a predetermined time, and for applying the speed factor signal to the signal representing the number of speed indication pulses received in a predetermined time to obtain an actual speed signal, and for applying the flow factor signal to the signal representing the number of fluid flow indication pulses received in a predetermined time to obtain an actual fluid flow rate signal, for multiplying the speed signal and the width signal and for dividing the result into the fluid flow rate signal to obtain a signal representative of the volume of fluid applied per unit area, and for applying the latter signal to the display.

2. A spray monitor as defined in claim 2, further comprising a counter controlled by the control means, manual means for causing the control means to display an incrementing count from the counter on the display, and manually controlled selector means for causing the control means to store the displayed count as the speed factor signal or the flow factor signal.

3. A spray monitor as defined in claim 2, in which the selector means is comprised of a switch in a circuit adapted to generate code signals, means for applying the code signals to the control means for causing the control means to store the displayed count as one of the speed factor signal, the flow factor signal or the spray width signal.

4. A spray monitor as defined in claim 3, in which the switch and associated circuit is adapted to generate code signals for causing the control means to display one of said signal representative of a volume of fluid producing said fluid flow indication signals, a volume of fluid per unit time, said signal representative of the actual speed of the vehicle, a signal representative of a distance as determined by a total count of the speed indication pulses modified by the speed factor signal, an area signal representative of the distance signal multiplied by the spray width signal, or a signal representative of the area signal divided by the elapsed time in predetermined units.

5. A spray monitor as defined in claim 4 in which the circuit associated with the switch is an encoder having a plurality of data input terminals and a plurality of ncoded data output terminals, each of said input terminals being connected to a switch t rminal, m ans in the switch for connecting a selectabl one of the input terminals to a potential sourc of predetermined p larity, and for applying the pot ntial source of opposite polarity, and f r applying th p tential s urc of opposite polarity to the oth r input t rminals, said utput terminals being connected t the control means.

6. A spray monitor as defined in claim 1, 2 or 4 in which the control means is comprised of a microprocessor having an interrupt input, a NOR gate having its output connected to the interrupt input, means for applying the speed indication pulse signals and the fluid flow indication pulse signals to respective inputs of the NOR gate, and to inputs of respective individual transmission gates, the outputs of the transmission gates being connected to data bus inputs of the microprocessor, means for enabling the transmission gates by the microprocessor upon reception of a signal at said interrupt input, whereby one of the speed indication or fluid flow indication pulse signals is passed through an associated transmission gate to the microprocessor for counting and determination of its source.

7. A spray monitor as defined in claim 5, in which the control means is comprised of a microprocessor having an interrupt input, a NOR gate having its output connected to the interrupt input, means for applying the speed indication pulse signals and the fluid flow indication pulse signals to respective inputs of the NOR gate, and to inputs of respective individual transmission gates, the outputs of the transmission gates being connected to data bus inputs of the microprocessor, means for enabling the transmission gates by the microprocessor upon reception of a signal at said interrupt input, whereby one of the speed indication or fluid flow indication pulse signals is passed through an associated transmission gate to the microprocessor for counting and determination of its source.

8. A spray monitor as defined in claim 7, further including a speed indication signal generator comprising a carrier signal oscillator, a flow rate indicator for generating modulating signals connected to the output of the oscillator, a detector for the modulation signals imposed on the carrier signal connected to the output of the oscillator, a low pass filter connected to the output of the detector, a comparator connected to the output of the filter for passing signals applied thereto in excess of a predetermined threshold, and a flip flop having its clock input connected to the output of the comparator, one output of the flip flop being connected to one input of the NOR gate.

9. A spray monitor as defined in claim 8, the indicator including means for applying pulse signals from a metal detector, the metal detector being located adjacent a turbine having metal elements in a plurality of turbine paddles which is adapt d to b disposed in a fluid line, to th clock input of a second flip flop, on output of the sec nd flip flop being connected to a sec nd input of the NOR gate.

10. A spray monitor as defined in claim 9, further including circuit m ans connecting the

micr processor and the flip flops for resetting both flip flops upon detection of an int rrupt signal from the utput f th NOR gate.

11. A sprayer monitor for a spray vehicle comprising:

(a) means for sensing the speed of movement of the sprayer and for providing a first signal representative of said speed,

(b) means for sensing the rate of flow of a fluid to be sprayed and for providing a second signal representative of said rate of flow.

(c) means for storing a signal representative of the spray width of the sprayer,

(d) a display, and

(e) control means for receiving said signals and for generating a display operating signal and applying it to the display, which corresponds to the value of the second signal divided by the product of the first and third signals, representing the values of fluid sprayed per unit acre.

12. A sprayer monitor as defined in claim 11, in which each said means for sensing is comprised of means for generating pulses at rates representative of said speed and said fluid flow rate respectively, and in which the control means includes means for receiving said pulses, a clock, means for counting clock pulses, and means for registering the cl ck count reached each time one of said pulses is rec iv d, and for storing said successiv clock counts as signals representativ of said speed and flow rate.

13. A sprayer monitor as defined in claim 12, further including means for applying a sequentially changing number signal to said display, means for stopping the sequential change of said number, and means for entering a signal corresponding to the displayed number into the storage means as said third signal.

14. A sprayer monitor as defined in claim 11, 12 or 13 in which the means for sensing said speed is comprised of a metal detector for detecting a target mounted on a portion of said vehicle adapted to cycle with movement of the vehicle.

15. A sprayer monitor as defined in claim 11, 12 or 13 in which the means for sensing the rate of flow of said vehicle is comprised of a turbine adapted to rotate under the influence of flow of said fluid and a circuit adapted to generate pulses upon detection of the rotation of said turbine.

16. A spray monitor as claimed in claim 1, substantially as described herein with reference to Figs. 3, 4, 5A, 5B, 6A, 6B, 7A, 7B, 8A, 8B, 9A, 9B, 10A, 10B and 11 of the accompanying drawings.

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